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(54) **HEADER TRANSITION CONNECTOR FOR AN ELECTRICAL CONNECTOR SYSTEM**

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USPC 439/607.07–607.1
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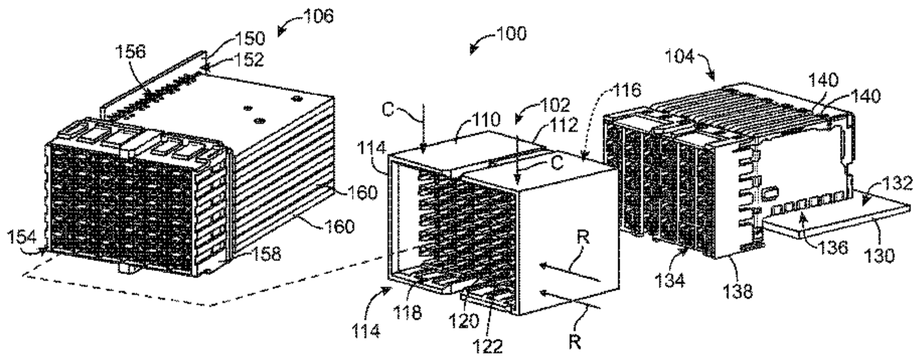
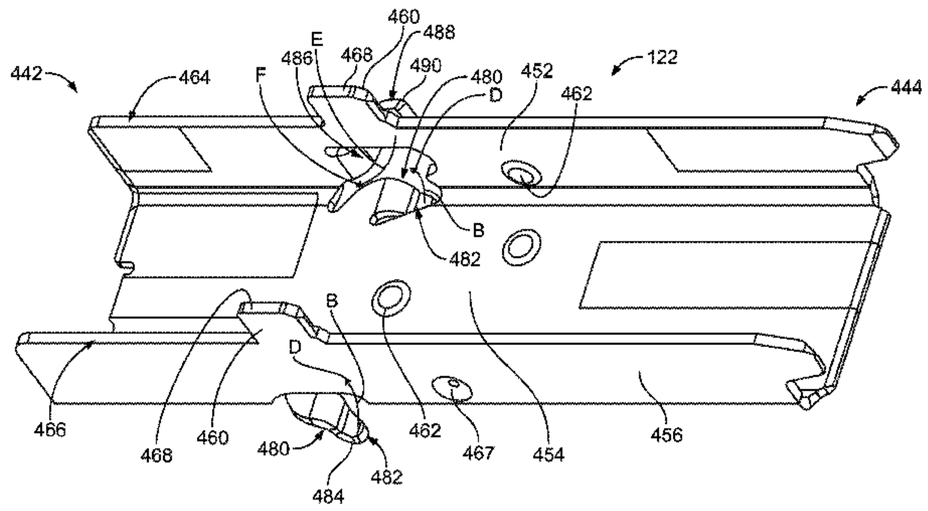
Primary Examiner — Abdullah Riyami
Assistant Examiner — Thang Nguyen

(57) **ABSTRACT**

A header transition connector includes a header housing having a separating wall separating a first cavity from a second cavity. Header signal contacts are held by the header housing. The header signal contacts are arranged in pairs carrying differential signals. The header signal contacts have first mating ends in the first cavity for mating with a first receptacle connector. The header signal contacts have second mating ends in the second cavity for mating with a second receptacle connector. Header ground shields are held by the header housing. The header ground shields have first mating ends in the first cavity for mating with the first receptacle connector. The header ground shields have second mating ends in the second cavity for mating with the second receptacle connector. At least a group of the header ground shields are electrically commoned with each other within the header housing.

21 Claims, 11 Drawing Sheets





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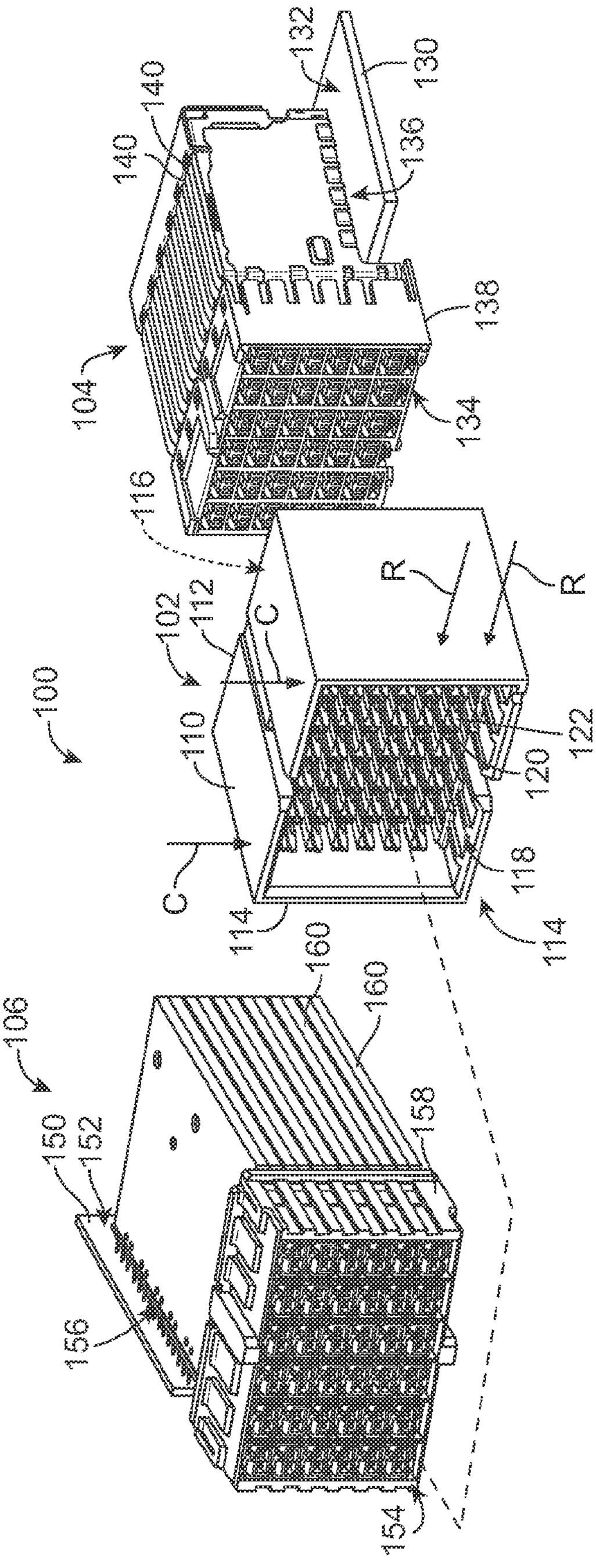
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102
104
106
110
112
114
116
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120
122
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152
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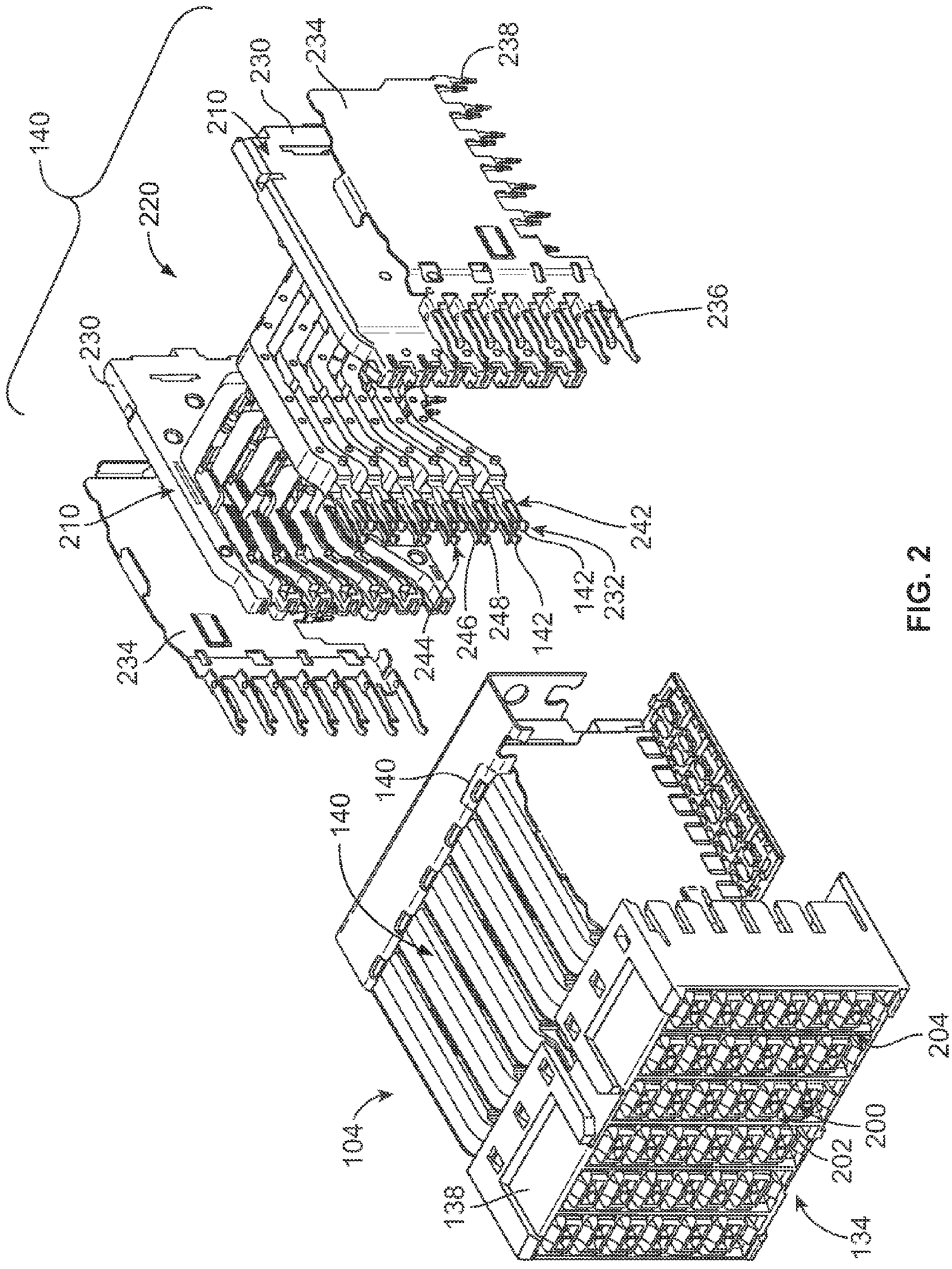
156
158
160
160
C
C
R
R

FIG. 1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220
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234
238
236
230
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142
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142
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234
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140
104
138
134
202
200
204

FIG. 2

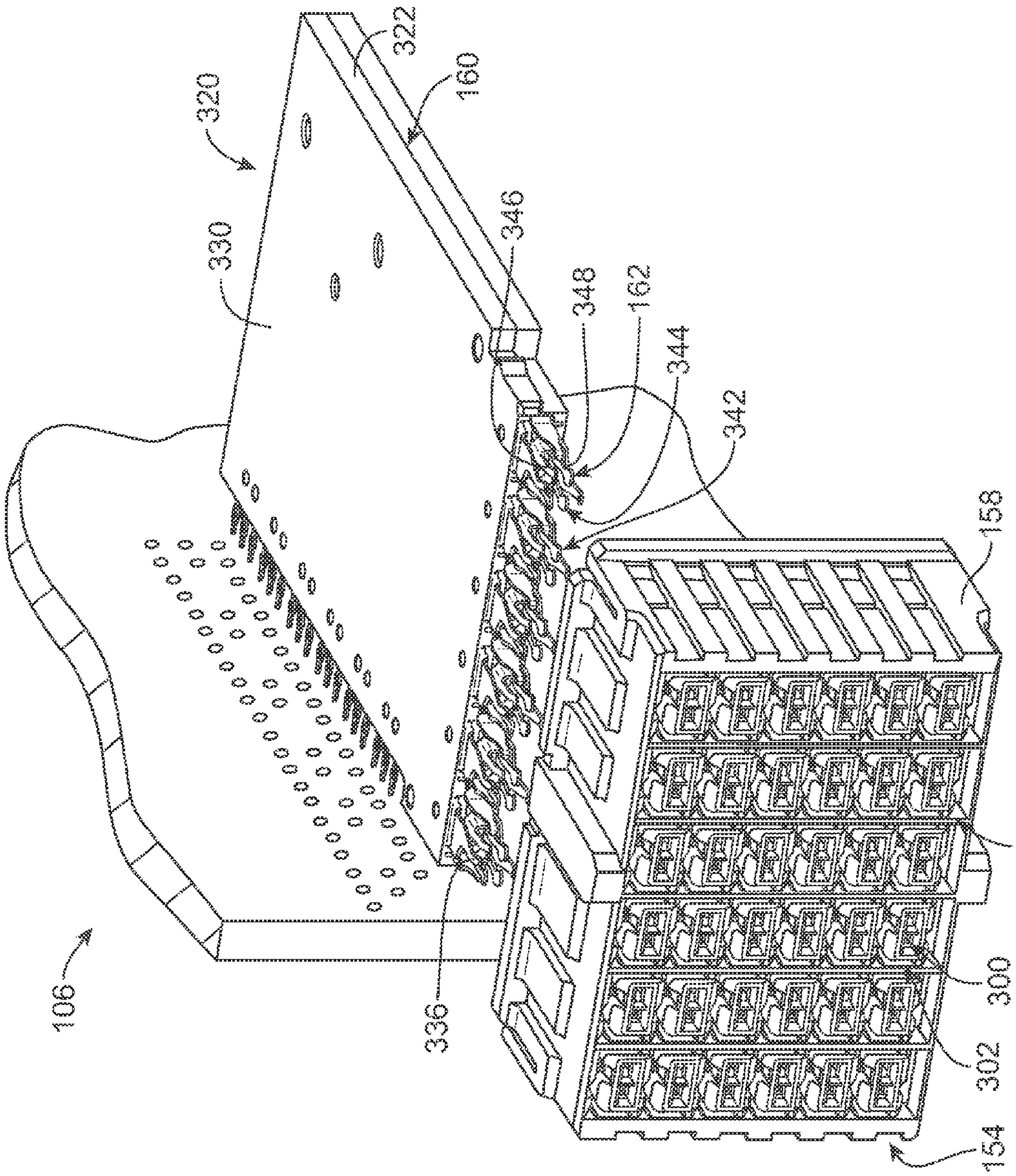
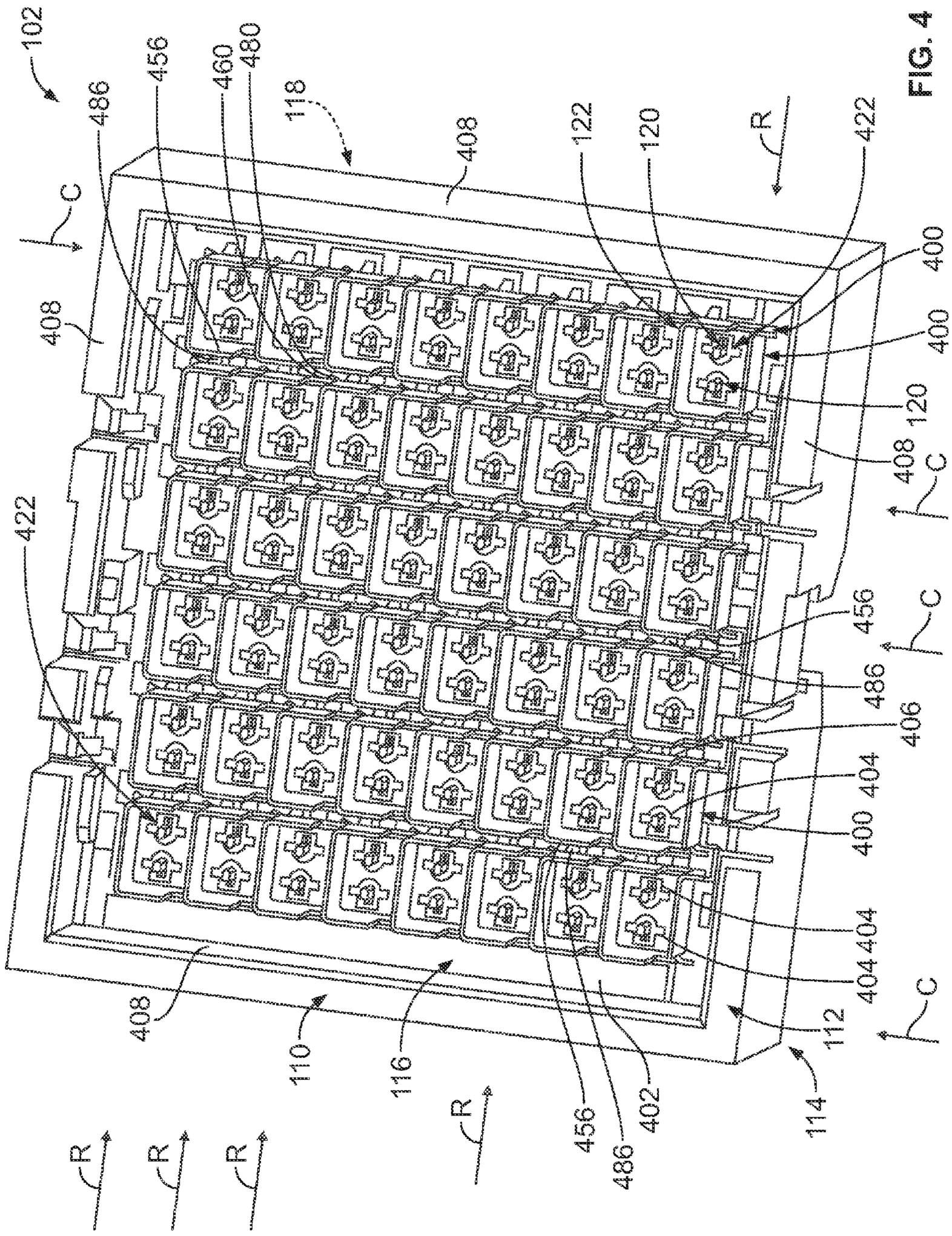


FIG. 3


102
486
456
460
480
118
408
122
120
R
422
C
400
408
120
C
422
456
C
486
406
404
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404
C
408
110
116
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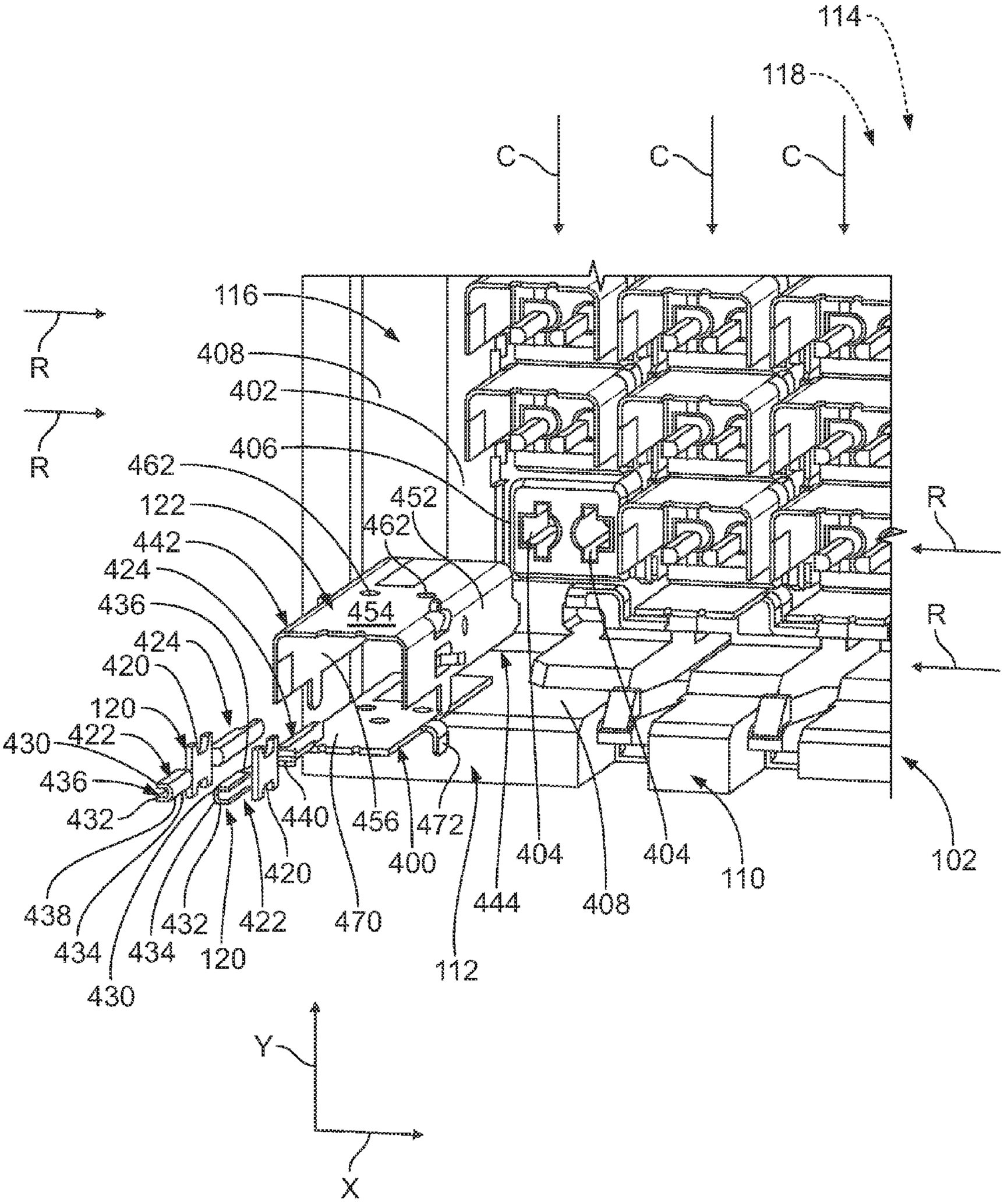
456
402
486
112
114
R
R
R

FIG. 4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116
408
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462
122
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438
434
434
432
422
120
420
440
456
472
400
470
112
444
404
404
408
110
102
452
462
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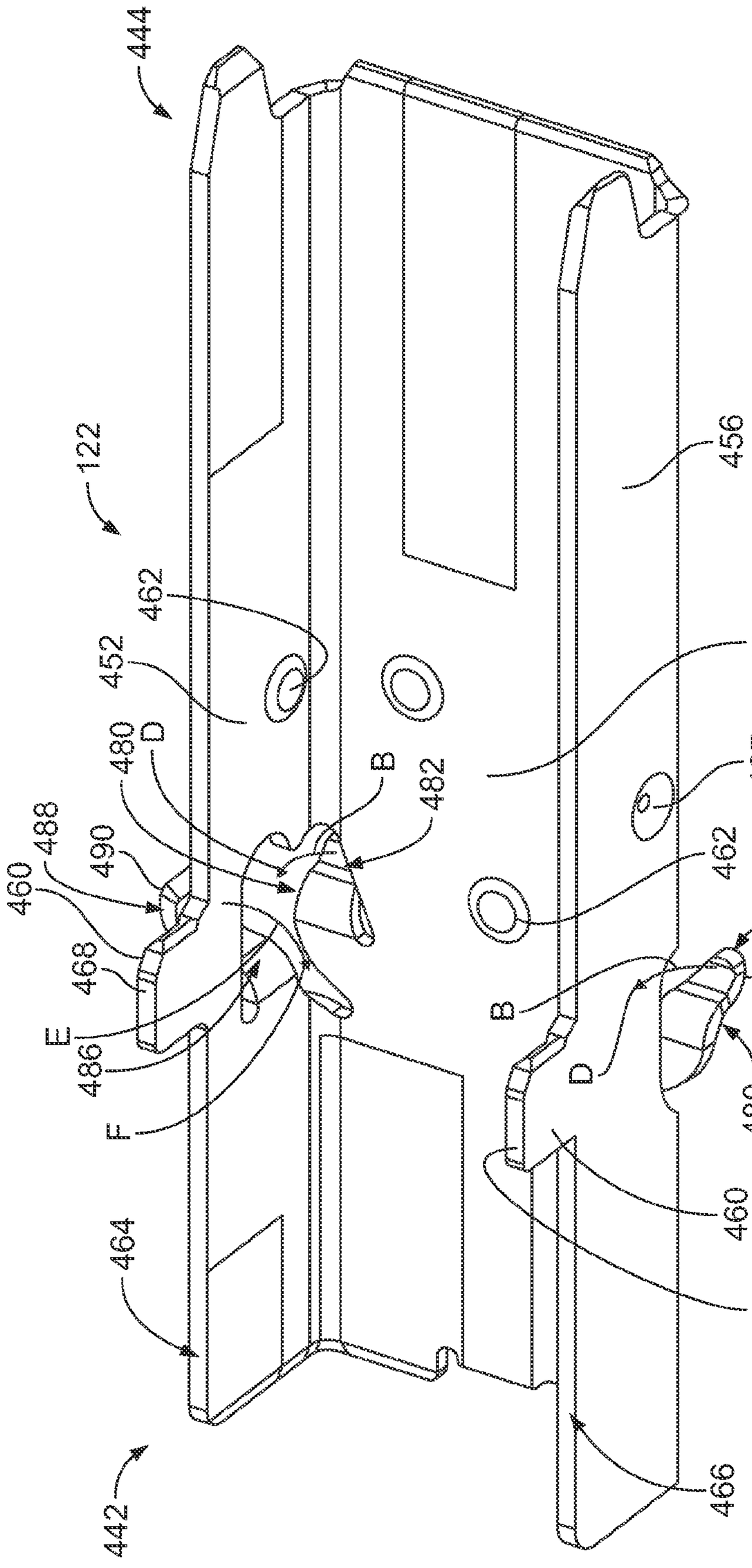
R
R
R
R
Y
X

FIG. 5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484
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466

FIG. 6

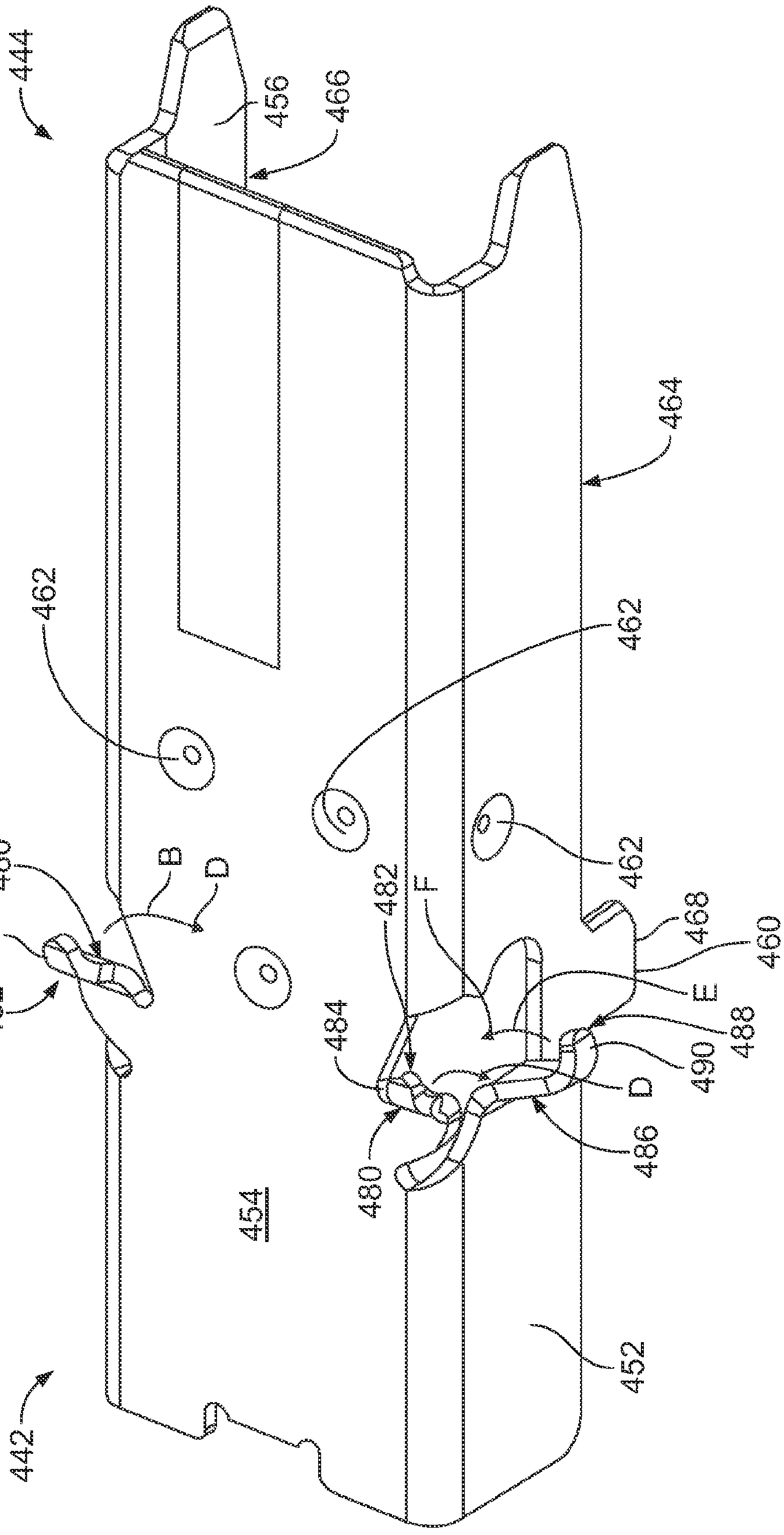
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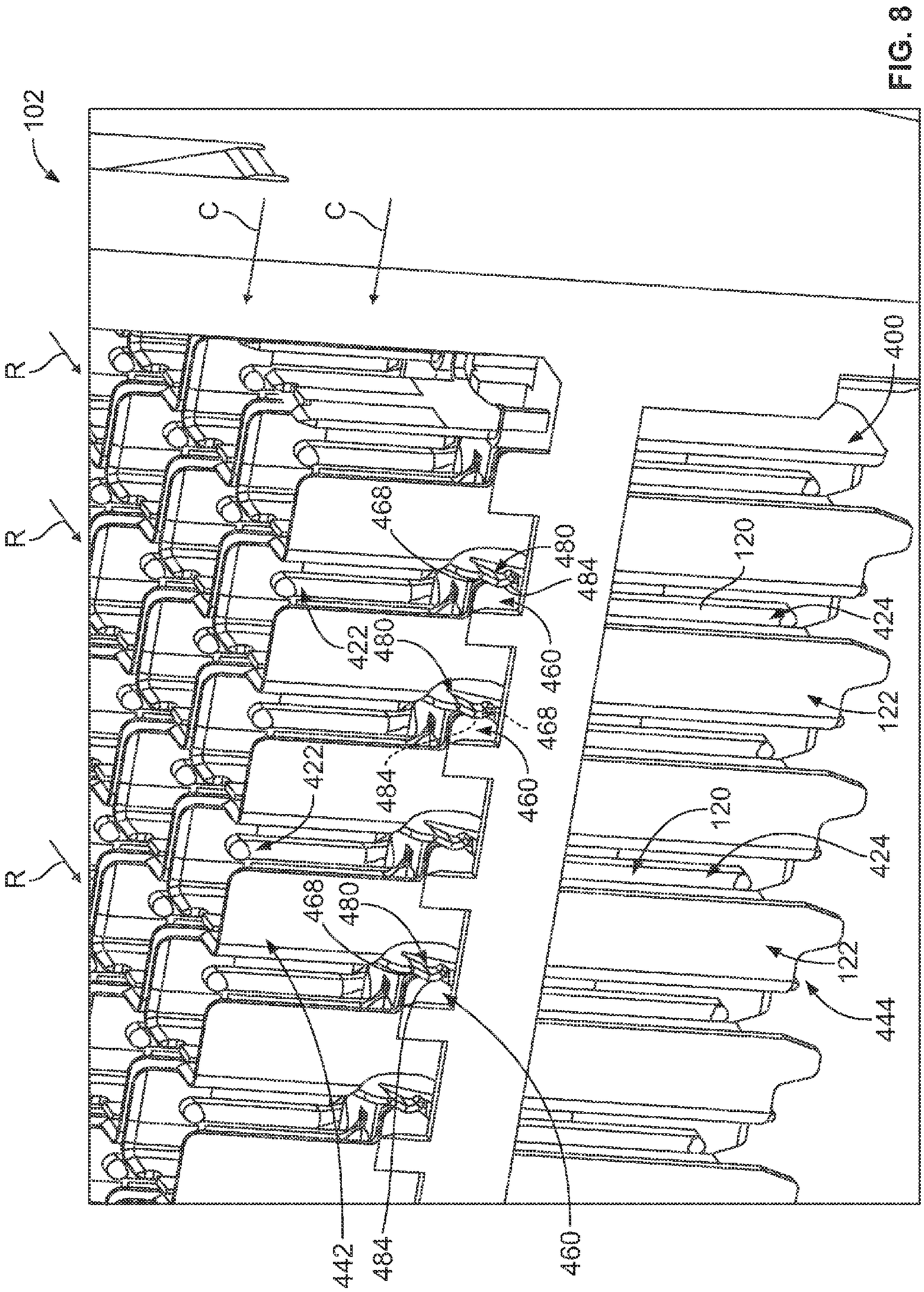
FIG. 7

FIG. 8



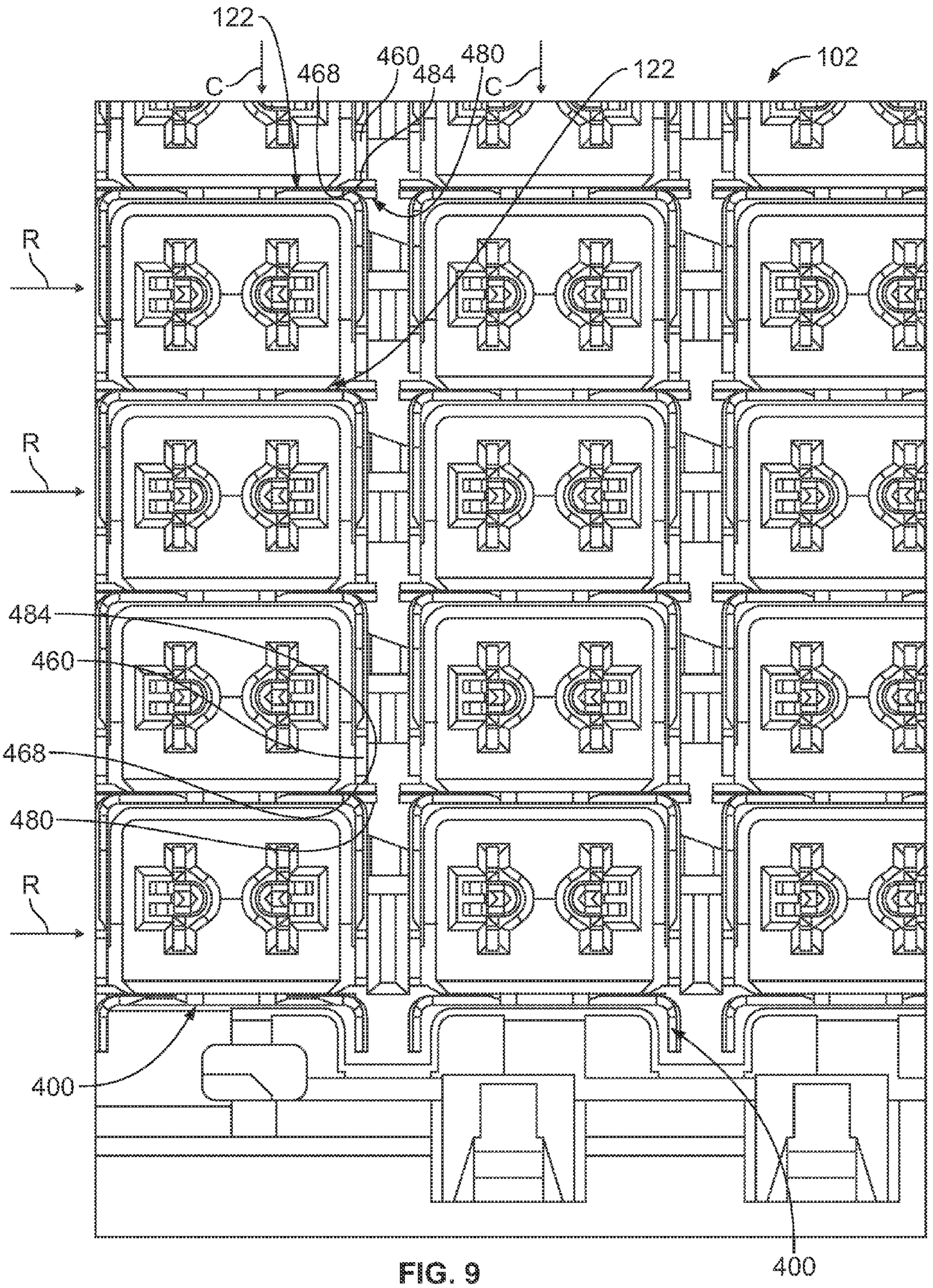


FIG. 9

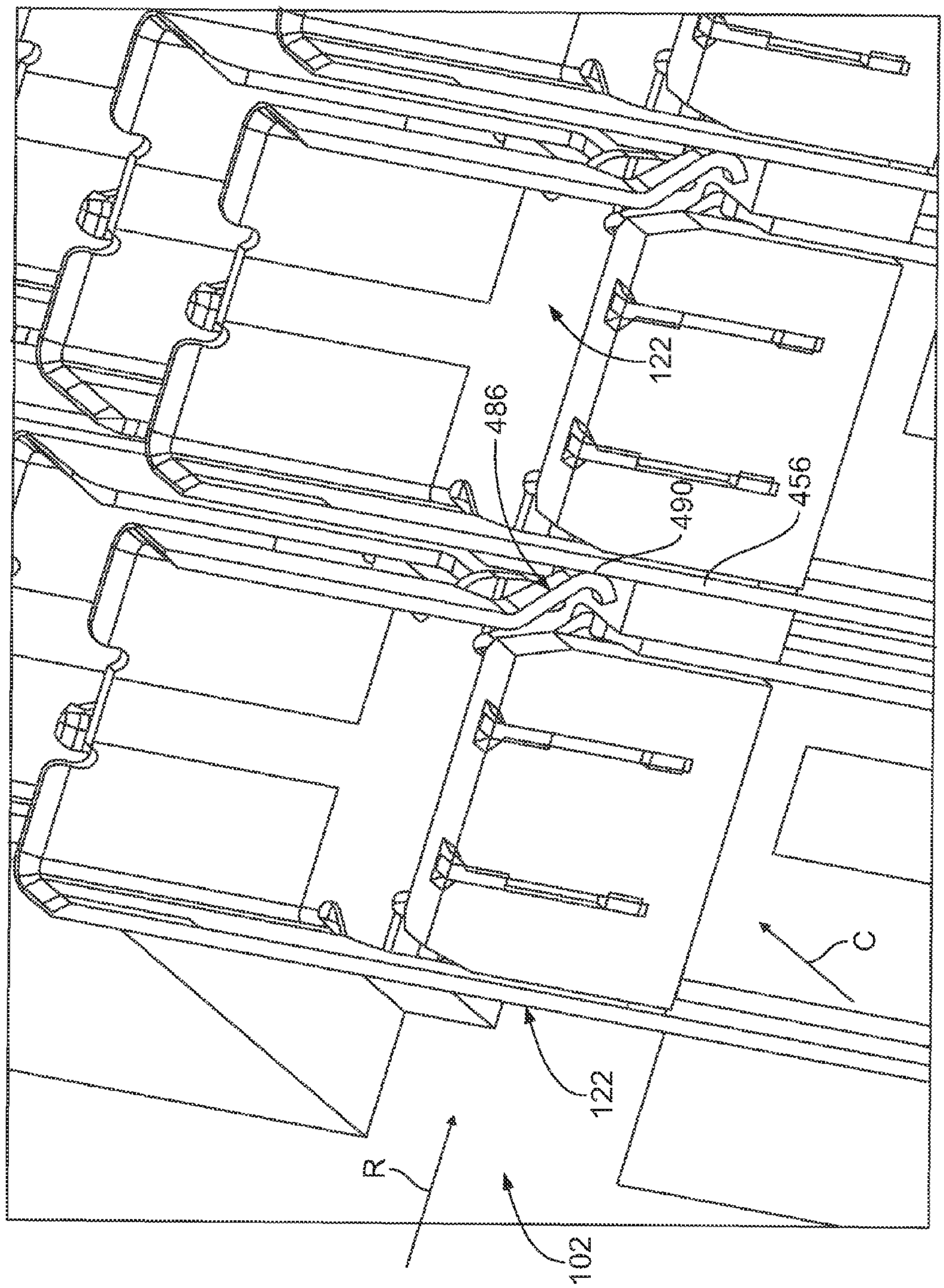


FIG. 10

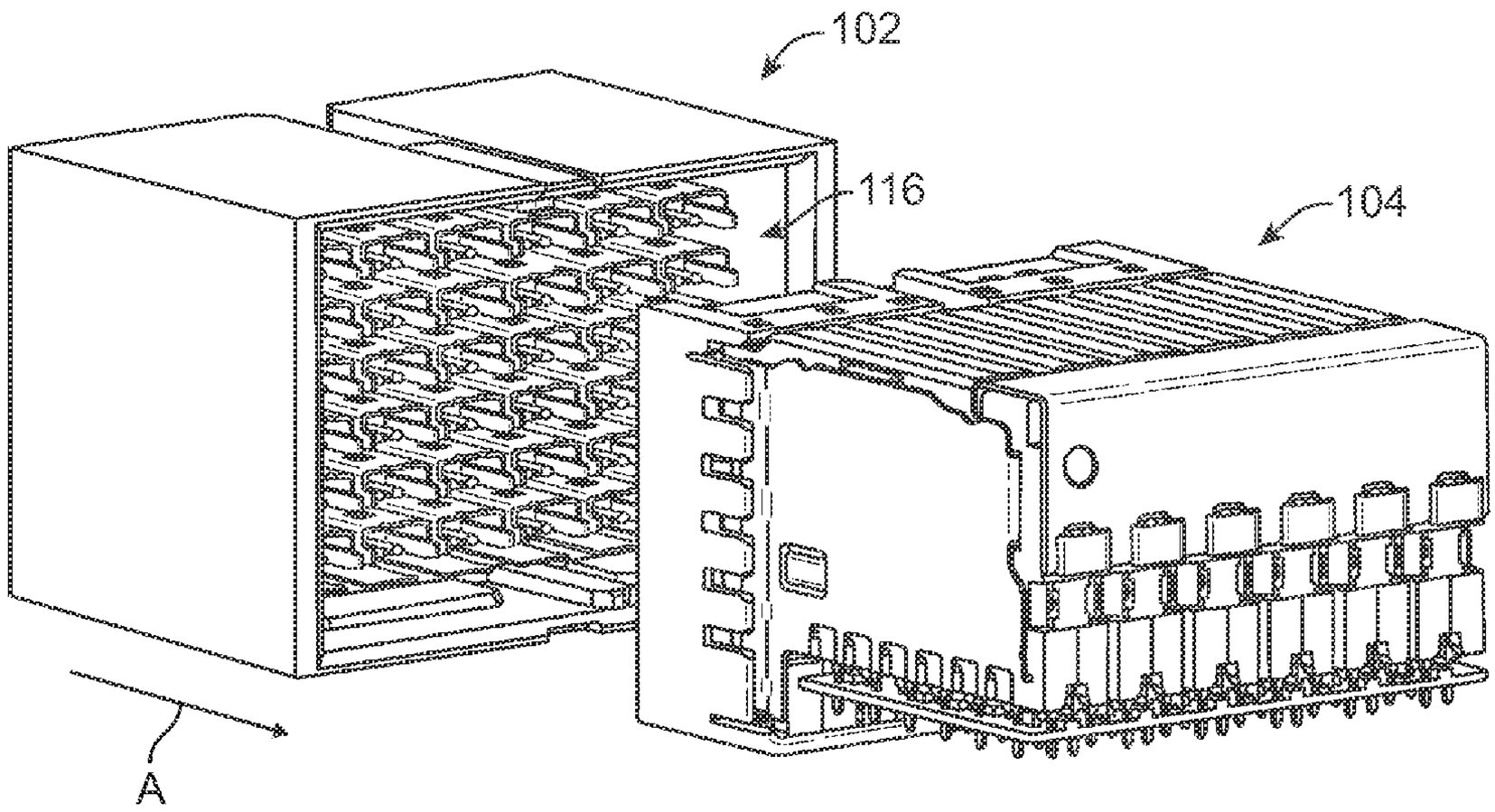


FIG. 11

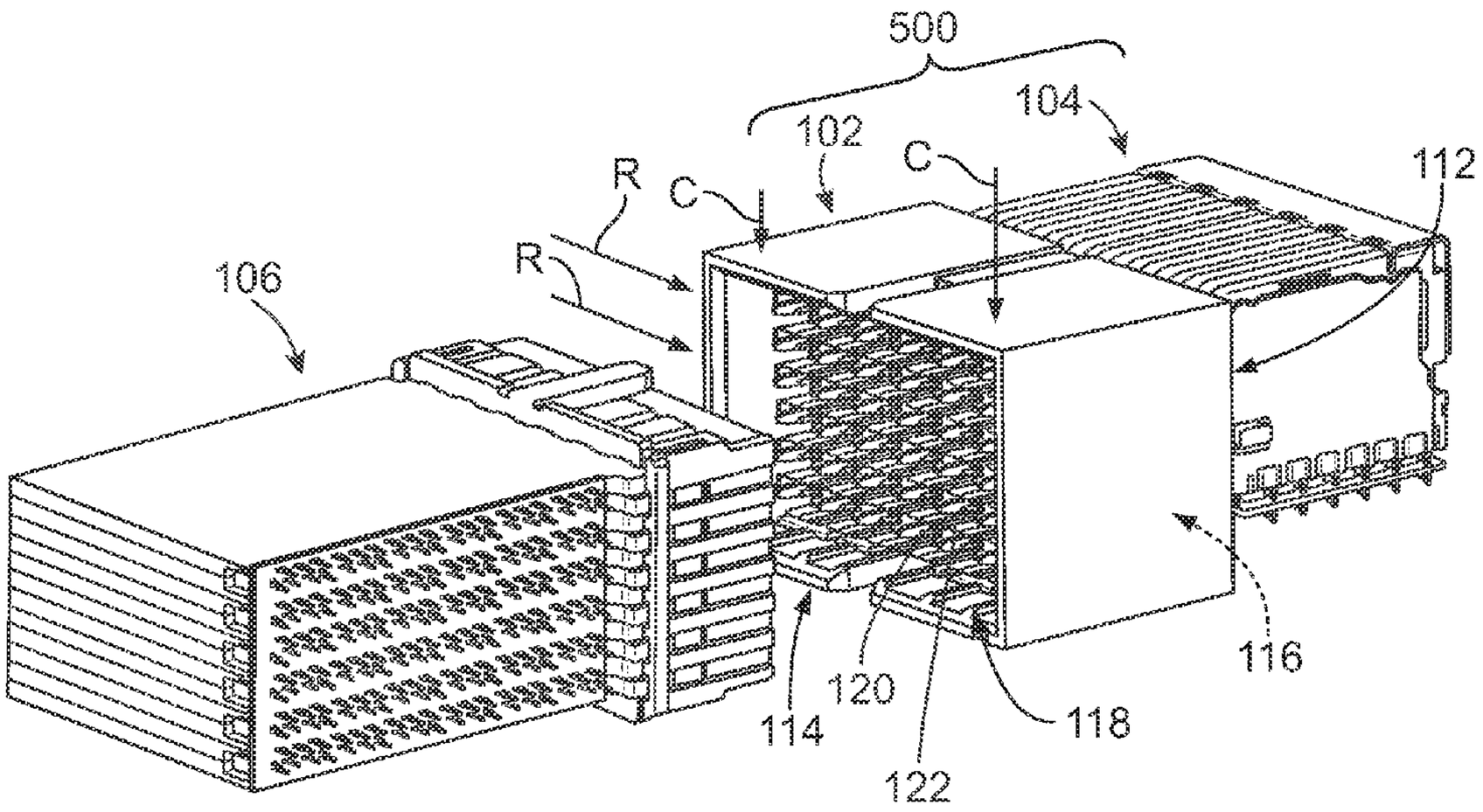


FIG. 12

HEADER TRANSITION CONNECTOR FOR AN ELECTRICAL CONNECTOR SYSTEM

BACKGROUND OF THE INVENTION

The subject matter herein relates generally to a header transition connector for use in an electrical connector system.

Some electrical systems, such as network switches and computer servers with switching capability, include receptacle connectors that are oriented orthogonally on opposite sides of a midplane in a cross-connect application. Switch cards may be connected on one side of the midplane and line cards may be connected on the other side of the midplane. The line card and switch card are joined through header connectors that are mounted on opposite sides of the midplane board. Using the midplane circuit board and header connectors adds to the cost and overall size of the electrical systems. Some known electrical systems have eliminated the midplane and header connectors by designing two connectors that mate directly to one another. But, midplanes typically include circuitry that cancels noise generated when passing an array of signals between the receptacle connectors. For example, signal noise may be generated from the array of signals passing through electrical vias of the switch and line cards and/or from the array of signals passing through the signal contacts of the receptacle connectors. Such known electrical systems having two connectors that mate directly together therefore may suffer from unwanted signal noise because of the absence of the midplane.

A need remains for an improved electrical connector system for mating receptacle connectors without a midplane circuit board.

BRIEF DESCRIPTION OF THE INVENTION

In an embodiment, a header transition connector includes a header housing having a separating wall separating a first cavity from a second cavity. Header signal contacts are held by the header housing. The header signal contacts are arranged in pairs carrying differential signals. The header signal contacts have first mating ends in the first cavity for mating with a first receptacle connector. The header signal contacts have second mating ends in the second cavity for mating with a second receptacle connector. Header ground shields are held by the header housing. The header ground shields have walls surrounding associated pairs of header signal contacts on at least two sides thereof. The header ground shields have first mating ends in the first cavity for mating with the first receptacle connector. The header ground shields have second mating ends in the second cavity for mating with the second receptacle connector. At least a group of the header ground shields are electrically commoned with each other within the header housing.

In an embodiment, a header transition connector includes a header housing having a separating wall separating a first cavity from a second cavity. Header signal contacts are held by the header housing. The header signal contacts are arranged in pairs carrying differential signals. The header signal contacts have first mating ends in the first cavity for mating with a first receptacle connector. The header signal contacts have second mating ends in the second cavity for mating with a second receptacle connector. Header ground shields are held by the header housing. The header ground shields have walls surrounding associated pairs of header signal contacts on at least two sides thereof. The header ground shields have first mating ends in the first cavity for mating with the first receptacle connector. The header ground shields have second mating ends in the second cavity for mating with the second receptacle connector. A first of the header ground shields is engaged in physical contact with a second of the header ground shields such that the first and second header ground shields are electrically connected together.

In an embodiment, an electrical connector system includes a receptacle connector having receptacle signal contacts arranged in pairs carrying differential signals. The receptacle connector includes a ground shield having ground contacts extending therefrom. A header transition connector is coupled to the receptacle connector. The header transition connector includes a header housing holding header signal contacts and header ground shields. The header housing have a separating wall separating a first cavity from a second cavity. The receptacle connector is configured to be received in the first cavity. The header signal contacts are arranged in pairs carrying differential signals. The header signal contacts have first mating ends that extend in the first cavity and are configured to be mated with the receptacle signal contacts of the receptacle connector. The header signal contacts have second mating ends that extend in the second cavity for mating with a second receptacle connector. The header ground shields have first mating ends in the first cavity for mating with the ground contacts of the receptacle connector. The header ground shields have second mating ends in the second cavity for mating with the second receptacle connector. A first of the header ground shields is engaged in physical contact with a second of the header ground shields such that the first and second header ground shields are electrically connected together.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an embodiment of an electrical connector system.

FIG. **2** is a front, partially exploded perspective view of an embodiment of a first receptacle connector of the electrical connector system shown in FIG. **1**.

FIG. **3** is a front perspective view of a portion of an embodiment of a second receptacle connector of the electrical connector system shown in FIG. **1**.

FIG. **4** is a perspective view of an embodiment of a header transition connector of the electrical connector system shown in FIG. **1**.

FIG. **5** is an enlarged partially exploded perspective view of the header transition connector shown in FIG. **4**.

FIG. **6** is a perspective view of an embodiment of a header ground shield of the header transition connector shown in FIGS. **4** and **5**.

FIG. **7** is another perspective view of the header ground shield shown in FIG. **6** viewed in a different orientation as compared to FIG. **6**.

FIG. **8** is a perspective view of the header transition connector shown in FIGS. **4** and **5** illustrating a cross section of the header transition connector.

FIG. **9** is an elevational view of a portion of the header transition connector shown in FIGS. **4**, **5**, and **8**.

FIG. **10** is a perspective view of the header transition connector shown in FIGS. **4**, **5**, **8**, and **9** illustrating another cross section of the header transition connector.

FIG. **11** illustrates the header transition connector shown in FIGS. **4**, **5**, and **8-10** poised for mating with the first receptacle connector shown in FIG. **2**.

FIG. **12** is a front perspective view of the header transition connector shown in FIGS. **4**, **5**, and **8-10** coupled to the first receptacle connector shown in FIG. **2** to form a header assembly.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** is a perspective view of an embodiment of an electrical connector system **100**. The electrical connector system **100** includes a header transition connector **102**, a first receptacle connector **104** configured to be coupled to one side of the header transition connector **102**, and a second receptacle connector **106** configured to be connected to another side the header transition connector **102**. The header transition connector **102** is used to electrically connect the first and second receptacle connectors **104** and **106** together. Optionally, the first receptacle connector **104** is part of a daughter card and the second receptacle connector **106** is, or forms a portion of, a backplane, or vice versa. The first and second receptacle connectors **104** and/or **106** may be, and/or may form a portion of, a line card and/or a switch card.

The header transition connector **102** makes direct electrical connections to both receptacle connectors **104** and **106** without the need for a midplane circuit board (not shown). The header transition connector **102** is a single connector that is able to electrically interconnect the two receptacle connectors **104** and **106**. Each of the receptacle connectors **104** and **106** may be any type of receptacle connector, such as, but not limited to, STRADA Whisper receptacle connectors commercially available from TE Connectivity, Harrisburg PA. The header transition connector **102** allows convenient electrical connection between the receptacle connectors **104** and **106**, with few parts and without the need for a midplane circuit board.

As will be described below, the header transition connector **102** includes header ground shields **122**. At least some (e.g., a group as will be described below) of the header ground shields **122** are electrically commoned with each other within a header housing **110** (described below) of the header transition connector **102**. Electrically commoning at least some of the header ground shields **122** within the header housing **110** may provide an electrical connector system **100** that mates the receptacle connectors **104** and **106** together without a midplane circuit board but that behaves electrically as if a midplane circuit board is present.

In an exemplary embodiment, the header transition connector **102** may be coupled to one of the receptacle connectors (e.g., the first receptacle connector **104**) to change the mating interface presented to the other receptacle connector (e.g., the second receptacle connector **106**). For example, the first receptacle connector **104** may have contacts each having a receptacle type mating end, such as, but not limited to, a split beam type of contact that defines a receptacle. The second receptacle connector **106** may have similar or identical contacts as the first receptacle connector **104**, such as, but not limited to, split beam type of contacts that define receptacles. The receptacle connectors **104** and **106** have mating interfaces that do not allow direct mating therebetween; however, the header transition connector **102** is able to mate directly with the first receptacle connector **104** and is able to mate directly with the second receptacle connector **106**. The header transition connector **102** is an adaptor that facilitates electrical interconnection of the receptacle connectors **104** and **106**. For example, the header transition connector **102** may include pin-type contacts at both mating interfaces of the header transition connector **102** that are able to be mated with the receptacle type contacts of both of the receptacle connectors **104** and **106**. In such an example, mounting the header transition connector **102** to the first receptacle connector **104** changes the mating interface presented to the second receptacle connector **106** from a receptacle contact type of interface to a pin contact type of interface. The header transition connector **102** thus defines an adapter that changes the mating interface of the receptacle connector **104** for mating with another connector, for example the receptacle connector **106**, that could not mate directly with the receptacle connector **104**.

The header transition connector **102** includes the header housing **110** having a first end **112** and a second end **114**. The header housing **110** defines a first cavity **116** (visible in FIGS. **4** and **5**) at the first end **112** and a second cavity **118** at the second end **114**. In an exemplary embodiment, the first cavity **116** receives the first receptacle connector **104** and the second cavity **118** receives the second receptacle connector **106**. The header transition connector **102** includes header signal contacts **120** held by the header housing **110** and header ground shields **122** held by the header housing **110**. The header signal contacts **120** are arranged in both the cavities **116** and **118** for mating with the first and second receptacle connectors **104** and **106**. Optionally, the header signal contacts **120** may be arranged in pairs carrying differential signals. The header ground shields **122** are arranged in both the cavities **116** and **118** for mating with both of the receptacle connectors **104** and **106**. The header ground shields **122** provide electrical shielding for the header signal contacts **120**.

In the illustrated embodiment, the header signal contacts **120** have an identical pinout in both the cavities **116** and **118** allowing the first receptacle connector **104** to be loaded into either the first cavity **116** or the second cavity **118**. Similarly, the second receptacle connector **106** may be loaded into either the first cavity **116** or the second cavity **118**. Optionally, identical receptacle connectors may be loaded into both cavities **116** and **118** for electrical connection by the header transition connector **102**. For example, two receptacle connectors that are identical to the first receptacle connector **104** (which may be referred to as "pair-in-row" receptacle connectors) may be plugged into the cavities **116** and **118**. Alternatively, two receptacle connectors that are identical to the second receptacle connector **106** (which may be referred to as "pair-in-column" receptacle connectors) may be plugged into the cavities **116** and **118**. The header transition connector **102** can accommodate either type of receptacle connector **104** or **106** in either cavity **116** or **118**.

Each of the header ground shields **122** peripherally surrounds an associated pair of the header signal contacts **120** in the illustrated embodiment. Moreover, the illustrated embodiment of the header ground shields **122** are C-shaped, covering three sides of the associated pair of header signal contacts **120**. One side of the header ground shield **122** is open. In the illustrated embodiment, each of the header ground shields **122** has an open bottom, and an adjacent header ground shield **122** below the open bottom provides shielding across the open bottom. Each pair of header signal contacts **120** is therefore surrounded on all four sides thereof by the associated C-shaped header ground shield **122** and the adjacent header ground shield **122** below the pair of header signal contacts **120**. As such, the header ground shields **122** cooperate to provide circumferential electrical shielding for each pair of header signal contacts **120**. The header ground shields **122** electrically shield each pair of header signal contacts **120** from every other pair of header signal contacts **120**. For example, the header ground shields **122** may span

all direct line paths from any one pair of the header signal contacts **120** to any other pair of the header signal contacts **120** to provide electrical shielding across all of the direct line paths. In the illustrated embodiment, the header ground shield **122** spans entirely across the top of both header signal contacts within the associated pair. The header ground shield **122** may provide better electrical shielding than individual header ground contacts of at least some known header assemblies.

In some other embodiment, other types of header ground shields **122** may be provided. For example, L-shaped header ground shields **122** may be used that provide shielding on two sides of the associated pair of header signal contacts **120**, wherein cooperation with other header ground shields **122** provides electrical shielding on all sides (e.g. above, below, and on both sides of the pair). In some other embodiments, and for example, the header ground shields **122** may be associated with individual header signal contacts **120** as opposed to pairs of header signal contacts **120**.

The first receptacle connector **104** is mounted to a first circuit board **130** at a mounting surface **132** of the first circuit board **130**. The first receptacle connector **104** has a header interface **134** configured to be mated with the header transition connector **102**. The first receptacle connector **104** has a board interface **136** configured to be mounted to the mounting surface **132** of the first circuit board **130**. In the illustrated embodiment, the board interface **136** is orientated perpendicular to the header interface **134**. When the first receptacle connector **104** is coupled to the header transition connector **102**, the first circuit board **130** is orientated horizontally with the first receptacle connector **104** above the first circuit board **130**; however, other orientations are possible in other embodiments.

The first receptacle connector **104** includes a first receptacle housing **138** used to hold a plurality of first contact modules **140**. The contact modules **140** are held in a stacked configuration generally parallel to one another. In the illustrated embodiment, the contact modules **140** are oriented generally along vertical planes. The contact modules **140** hold a plurality of first receptacle signal contacts **142** (shown in FIG. **2**) that are electrically connected to the first circuit board **130** and define signal paths through the first receptacle connector **104**. The receptacle signal contacts **142** are configured to be electrically connected to the header signal contacts **120**. The contact modules **140** optionally provide electrical shielding for the receptacle signal contacts **142**. Optionally, the receptacle signal contacts **142** may be arranged in pairs carrying differential signals. The contact modules **140** may generally provide 360° shielding for each pair of receptacle signal contacts **142** along substantially the entire length of the receptacle signal contacts **142** between the board interface **136** and the header interface **134**. The shield structure of the contact modules **140** that provides the electrical shielding for the pairs of receptacle signal contacts **142** is electrically connected to the header ground shields **122** and is electrically connected to a ground plane of the first circuit board **130**.

In the illustrated embodiment, mating ends of the receptacle signal contacts **142** are arranged in an array in rows and columns (contained within the receptacle housing **138** and thus not shown in FIG. **1**; however the pattern is evident from the arrangement of the openings in the receptacle housing **138**). The receptacle signal contacts **142** within each contact module **140** define a column of signal contacts. The rows are defined as being oriented parallel to the mounting surface **132** of the first circuit board **130**. In the illustrated embodiment, the columns are oriented vertically and the rows are oriented horizontally. The receptacle signal contacts **142** within each pair are arranged in a same row, and thus the first receptacle connector **104** defines a pair-in-row receptacle connector. The receptacle signal contacts **142** within each contact module **140** are in a same column. Optionally, the contact modules **140** are manufactured using overmolded leadframes and the receptacle signal contacts **142** from a same leadframe are within a same column. The receptacle signal contacts **142** within each pair optionally are arranged in a same contact module **140**.

The second receptacle connector **106** is mounted to a second circuit board **150** at a mounting surface **152** of the second circuit board **150**. The second receptacle connector **106** is configured to be coupled to the header transition connector **102**. The second receptacle connector **106** has a header interface **154** configured to be mated with the header transition connector **102**. The second receptacle connector **106** has a board interface **156** configured to be mounted to the mounting surface **152** of the second circuit board **150**. In the illustrated embodiment, the board interface **156** is orientated perpendicular to the header interface **154**. When the second receptacle connector **106** is coupled to the header transition connector **102**, the second circuit board **150** is orientated vertically with the second receptacle connector **106** along one side of the second circuit board **150**; however, other orientations are possible in other embodiments. Optionally, the second circuit board **150** is oriented perpendicular to the first circuit board **130**, as is shown in the illustrated embodiment.

The second receptacle connector **106** includes a second receptacle housing **158** used to hold a plurality of second contact modules **160**. The contact modules **160** are held in a stacked configuration generally parallel to one another. In the illustrated embodiment, the contact modules **160** are oriented generally along horizontal planes. The contact modules **160** hold a plurality of receptacle signal contacts **162** (shown in FIG. **3**) that are electrically connected to the second circuit board **150** and define signal paths through the second receptacle connector **106**. The receptacle signal contacts **162** are configured to be electrically connected to the header signal contacts **120**. In an exemplary embodiment, the contact modules **160** provide electrical shielding for the receptacle signal contacts **162**. Optionally, the receptacle signal contacts **162** may be arranged in pairs carrying differential signals. The contact modules **160** may generally provide 360° shielding for each pair of receptacle signal contacts **162** along substantially the entire length of the receptacle signal contacts **162** between the board interface **156** and the header interface **154**. The shield structure of the contact modules **160** that provides electrical shielding for the pairs of receptacle signal contacts **162** is electrically connected to the header ground shields **122** of the header transition connector **102** and is electrically connected to a ground plane of the second circuit board **150**.

In the illustrated embodiment, mating ends of the receptacle signal contacts **162** are arranged in an array in rows and columns (contained within the receptacle housing **158** and thus not shown in FIG. **1**; however, the pattern is evident from the arrangement of the openings in the receptacle housing **158**). The receptacle signal contacts **162** within each contact module **160** define a column of signal contacts. The rows are defined as being oriented parallel to the mounting surface **152** of the second circuit board **150**. In the illustrated embodiment, the columns are oriented horizontally and the rows are oriented vertically. The receptacle signal contacts **162** within each pair are arranged in a same column, and thus the second receptacle connector **106** defines a pair-in-col-

umn receptacle connector. The receptacle signal contacts **162** within each contact module **160** are in a same column. Optionally, the contact modules **160** are manufactured using overmolded leadframes and the receptacle signal contacts **162** from a same leadframe are within a same column. Optionally, the receptacle signal contacts **162** within each pair are arranged in a same contact module **160**.

FIG. **2** is a front, partially exploded perspective view of an embodiment of the first receptacle connector **104**. The first receptacle housing **138** is manufactured from a dielectric material, such as, but not limited to, a plastic material. The first receptacle housing **138** includes a plurality of signal contact openings **200** and a plurality of ground contacts openings **202** that are through passages extending from the mating end **204** through the first receptacle housing **138**. The mating end **204** defines a portion of the header interface **134** of the first receptacle connector **104**.

The contact modules **140** are coupled to the first receptacle housing **138** such that the receptacle signal contacts **142** are received in corresponding signal contact openings **200**. Optionally, a single receptacle signal contact **142** is received in each signal contact opening **200**. The signal contact openings **200** may also receive corresponding header signal contacts **120** (shown in FIGS. **1**, **4**, **5**, **8**, and **12**) therein when the receptacle connector **104** is coupled to the header transition connector **102** (shown in FIGS. **1**, **2**, **11**, and **12**).

The ground contact openings **202** receive corresponding header ground shields **122** (shown in FIGS. **1**, **4-10**, and **12**) therein when the receptacle connector **104** is coupled to the header transition connector **102**. The ground contact openings **202** receive grounding members (e.g., grounding contacts **236** of the contact modules **140**), which mate with the header ground shields **122** to electrically common the grounding contacts **236** and the header ground shields **122**. The ground contact openings **202** are C-shaped in the illustrated embodiment to receive the C-shaped header ground shields **122**. Other shapes are possible in other embodiments, for example when other shaped header ground shields **122** are used.

The contact modules **140** each include a holder **210** that holds a frame assembly **220**. Optionally, the holder **210** may be an electrically conductive holder to provide electrical shielding, for example a holder manufactured from a metal material and/or a metalized plastic material. The frame assembly **220** includes a dielectric frame **230** surrounding a leadframe **232**. Optionally, the leadframe **232** is stamped and formed to define the receptacle signal contacts **142**. Other manufacturing processes may be utilized to form the contact modules **140**.

The conductive holder **210** provides electrical shielding for the receptacle signal contacts **142**. The conductive holder **210** may include portions that are positioned between some or all of the receptacle signal contacts **142** to provide electrical shielding. Optionally, a shield **234** may be coupled to the holder **210**. The shield **234** includes the grounding contacts **236** and grounding pins **238**, which may be electrically terminated to the circuit board **130**.

Although not shown in FIG. **2**, it should be apparent from the exploded portion of FIG. **2** that the receptacle signal contacts **142** have mating portions **242** that extend from the front wall of the dielectric frame **230**. The mating portions **242** are configured to be mated with, and electrically connected to, corresponding header signal contacts **120** (shown in FIGS. **1**, **4**, **5**, **8**, and **12**). The mating portions **242** within each contact module **140** are arranged in a column. The mating portions **242** define receptacle type mating ends having a receptacle **244** that is configured to receive a pin type contact, such as the header signal contact **120**. In the illustrated embodiment, each mating portion **242** is a split beam type of contact having opposed beams **246** and **248** defining and flanking the receptacle **244**. Other types of mating portions may be provided in other embodiments.

The mating portions **242**, the grounding contacts **236**, and the first receptacle housing **138** together define the header interface **134**. For example, the size and shape of the perimeter of the first receptacle housing **138** as well as the shapes and positions of the mating portions **242** and the grounding contacts **236** define the header interface **134**. For example, the mating portions **242** have a predetermined pinout defined by the relative positions of the mating portions **242**. The header interface **134** is configured for mating with the header transition connector **102** (shown in FIGS. **1**, **4**, **5**, and **8-12**).

The receptacle signal contacts **142** are optionally arranged as differential pairs. The pair of receptacle signal contacts **142** is arranged in a row, which defines the receptacle connector **104** as a pair-in-row receptacle connector **104**. The conductive holders **210** may be designed to provide electrical shielding between and around respective pairs of the receptacle signal contacts **142**. The conductive holders **210** may provide 360° shielding around each pair of receptacle signal contacts **142**. The conductive holders **210** provide shielding from electromagnetic interference (EMI) and/or radio frequency interference (RFI).

FIG. **3** is a front perspective view of a portion of an embodiment of the second receptacle connector **106**. FIG. **3** illustrates one of the contact modules **160** poised for loading into the second receptacle housing **158**. The second receptacle housing **158** is manufactured from a dielectric material, such as, but not limited to, a plastic material. The second receptacle housing **158** includes a plurality of signal contact openings **300** and a plurality of ground contacts openings **302** that are through passages that extend from a mating end **304** through the second receptacle housing **158**. The mating end **304** defines a portion of the header interface **154** of the second receptacle connector **106**.

The contact module **160** is coupled to the second receptacle housing **158** such that the receptacle signal contacts **162** are received in corresponding signal contact openings **300**. Optionally, a single receptacle signal contact **162** is received in each signal contact opening **300**. The signal contact openings **300** may also receive corresponding header signal contacts **120** (shown in FIGS. **1**, **4**, **5**, **8**, and **12**) therein when the receptacle connector **106** is mated with the header transition connector **102** (shown in FIGS. **1**, **4**, **5**, and **8-12**).

The ground contact openings **302** receive corresponding header ground shields **122** (shown in FIGS. **1**, **4-10**, and **12**) therein when the receptacle connector **106** is mated with the header transition connector **102**. The ground contact openings **302** receive grounding members, for example grounding contacts **336** of the contact modules **160**, which mate with the header ground shields **122**. The ground contact openings **302** are C-shaped in the illustrated embodiment to receive the C-shaped header ground shields **122**. Other shapes are possible in other embodiments, such as, but not limited to, when other shaped header ground shields **122** are used.

The contact module **160** includes a frame assembly **320**, which includes the receptacle signal contacts **162**. The receptacle signal contacts **162** are arranged in pairs carrying differential signals. Optionally, the frame assembly **320** includes a dielectric frame **322** that surrounds the receptacle

signal contacts. The dielectric frame **322** optionally is overmolded over a leadframe, which is optionally stamped and formed to define the receptacle signal contacts **162**.

The contact module **160** may include a shield **330** that provides shielding for the receptacle signal contacts **162**. In the illustrated embodiment, portions of the shield **330** are positioned between pairs of the receptacle signal contacts **162** to provide shielding between adjacent pairs of the receptacle signal contacts **162**. The shield **330** provides electrical shielding between and around respective pairs of the receptacle signal contacts **162**. The shield **330** includes the grounding contacts **336** that provide shielding for mating portions **342** of the receptacle signal contacts **162**. Optionally, the shield **330** may be a multi-piece shield. For example, the grounding contacts **336** may be separately stamped and formed from grounding bars that are mechanically and electrically connected to the base structure of the shield **330**. The grounding contacts **336** may extend along three sides of the pair of receptacle signal contacts **162**.

The mating portions **342** extend from the front wall of the dielectric frame **322**. The mating portions **342** are configured to be mated with and electrically connected to corresponding header signal contacts **120** (shown in FIGS. **1**, **4**, **5**, **8**, and **12**). The mating portions **342** within each contact module **160** are arranged in a column. The mating portions **342** define receptacle type mating ends having a receptacle **344** that is configured to receive a pin type contact, for example the header signal contact **120**. In the illustrated embodiment, each mating portion **342** is a split beam type of contact having opposed beams **346**, **348** defining and flanking the receptacle **344**. Other types of mating portions may be provided in other embodiments.

The mating portions **342**, the grounding contacts **336**, and the second receptacle housing **158** together define the header interface **154**. For example, the size and shape of the perimeter of the second receptacle housing **158** as well as the shapes and positions of the mating portions **342** and the grounding contacts **336** define the header interface **154**. For example, the mating portions **342** have a predetermined pinout defined by the relative positions of the mating portions **342**. Optionally, the pinout may be identical to the pinout defined by the first receptacle connector **104** (shown in FIGS. **1**, **2**, **11**, and **12**) such that the receptacle connectors **104** and **106** are interchangeable and configured to be mated to either end **112** or **114** (both shown in FIGS. **1**, **4**, **5**, and **12**) of the header transition connector **102**.

Optionally, the receptacle signal contacts **162** are arranged as differential pairs. Both receptacle signal contacts **162** of each pair optionally are part of the same contact module **160**. The pair of receptacle signal contacts **162** is arranged in the column defined by the contact module **160** and as such the receptacle connector **106** is a pair-in-column receptacle connector **106**.

FIG. **4** is a perspective view of an embodiment of the header transition connector **102**. FIG. **5** is an enlarged partially-exploded perspective view of the header transition connector **102**. FIG. **5** illustrates a portion of the header transition connector **102** showing an orphan ground shield **400**, a pair of the header signal contacts **120** and one of the header ground shields **122** poised for loading into the header housing **110**.

Referring now to FIGS. **4** and **5**, the header housing **110** of the header transition connector **102** is manufactured from a dielectric material, for example a plastic material. The header housing **110** includes a separating wall **402** between the first cavity **116** and the second cavity **118** (visible in FIG. **1**). The separating wall **402** includes signal contact openings **404** that receive corresponding header signal contacts **120** and ground shield openings **406** that receive corresponding header ground shields **122**. The signal contact openings **404** are sized and shaped to hold the header signal contacts **120** therein. The ground shield openings **406** are sized and shaped to hold the header ground shields **122** therein.

The header housing **110** includes shroud walls **408** extending from the separating wall **402** to the first end **112** and the second end **114**. The shroud walls **408** define the cavities **116** and **118**. The shroud walls **408** surround exposed portions of the header signal contacts **120** and the header ground shields **122**. The receptacle connectors **104** (shown in FIGS. **1**, **2**, **11**, and **12**) and **106** (shown in FIGS. **1**, **3**, **11**, and **12**) are configured to be coupled to the shroud walls **408**. During mating, the shroud walls **408** may guide the receptacle connectors **104** and **106** into the cavities **116** and **118**, respectively, or vice versa.

Referring now solely to FIG. **5**, the orphan ground shield **400** is positioned in the corresponding ground shield opening **406** below the bottom-most pair of header signal contacts **120**. The orphan ground shield **400** provides shielding below the bottom-most pair of header signal contacts **120**. In the illustrated embodiment, the orphan ground shield **400** includes a single planar wall **470**; however, the orphan ground shield **400** may include multiple walls in other embodiments.

The orphan ground shield **400** includes one or more optional tabs **472** extending from the wall **470**. The tabs **472** are used to stop or locate the orphan ground shield **400** in the corresponding ground shield opening **406**, for example to limit the amount that the orphan ground shield **400** is loaded into the corresponding ground shield opening **406**. The tabs **472** may define push surfaces for pushing or loading the orphan ground shield **400** into the corresponding ground shield opening **406**. Optionally, the first receptacle connector **104** (shown in FIGS. **1**, **2**, **11**, and **12**) or the second receptacle connector **106** (shown in FIGS. **1**, **3**, **11**, and **12**) may be positioned immediately behind the tabs **472** within the cavity **116** or within the cavity **118** to block the orphan ground shield **400** from being pushed out of the corresponding ground shield opening **406**, for example when the other receptacle connector **104** or **106** is loaded into the other cavity **116** or **118**.

Although the wall **470** is shown as an integrally formed single, unitary structure, alternatively the wall **470** is formed from two or more separately (i.e., discretely) formed structures.

Optionally, the header signal contacts **120** are substantially similar to each other. Each header signal contact **120** includes a base section **420**, which may be approximately centered along a length of the header signal contact **120**. Optionally, the header signal contact **120** is a stamped and formed contact. The base section **420** is configured to be received in the corresponding signal contact opening **404** and held therein, such as by an interference fit.

The header signal contact **120** includes a first mating end **422** extending from one side of the base section **420** and a second mating end **424** extending from the opposite side of the base section **420**. The first mating end **422** is configured to extend into the first cavity **116** for mating with a respective signal contact **142** (FIG. **2**) of the first receptacle connector **104**. The second mating end **424** is configured to extend into the second cavity **118** for mating with a respective signal contact **162** (FIG. **3**) of the second receptacle connector **106**. In the illustrated embodiment, each of the

mating ends **422** and **424** defines a pin type contact having a generally equal width and height (defined in the X and Y directions, respectively).

In the illustrated embodiment, each of the mating ends **422** and **424** is formed into a U-shaped pin. For example, with reference to the first mating end **422** (the second mating end **424** may be formed in a similar manner), the pin is formed by bending or rolling an upper shoulder **430** and a lower shoulder **432** with a connecting segment **434** therebetween. The connecting segment **434** may be curved. In the illustrated embodiment, the upper and lower shoulders **430** and **432**, respectively, are generally planar and parallel to one another with a gap **436** therebetween. In other embodiments, the shoulders **430** and **432** may be curved and distal ends of the upper and lower shoulder may abut one another, for example to form a round or O-shaped pin rather than the U-shaped pin shown in the illustrated embodiment. Optionally, a tip **438** is formed at the distal end of the first mating end **422**. The tip **438** reduces stubbing with the receptacle signal contact **142** during mating.

The upper and lower shoulders **430** and **432**, respectively, may be compressible toward one another. For example, the shoulders **430** and **432** may be resiliently deflected by the beams **246** and **248** (shown in FIG. **2**) of the corresponding receptacle signal contact **142** (shown in FIG. **2**) when received in the receptacle **244** (shown in FIG. **2**) thereof. The upper shoulder **430** defines an upward facing mating interface for mating with the upper beam **246** of the receptacle signal contact **142**. The lower shoulder **432** defines a downward facing mating interface for mating with the lower beam **248** of the receptacle signal contact **142**. The upper shoulder **430** and the lower shoulder **432** are both perpendicular to the base section **420**.

In the illustrated embodiment, the upper shoulder **430** and the lower shoulder **432** are parallel to corresponding upper and lower shoulders **430** and **432**, respectively, of the second mating end **424**. Optionally, the upper shoulder **430** and the lower shoulder **432** are coplanar with the upper and lower shoulders **430** and **432**, respectively, of the second mating end **424**. Optionally, the shoulders **430** and **432** of the second mating end **424** include ramps **440** extending therefrom that are used to control impedance, for example when the second receptacle connector **106** is not fully mated.

In the illustrated embodiment of the header signal contacts **120**, the various structures of each of the header signal contacts **120** are integrally formed as a single, unitary structure. Alternatively, one or more of the various structures of a header signal contact **120** (e.g., the first mating end **422**, the second mating end **424**, and/or the base section **420**) is separately (i.e., discretely) formed as a separate (i.e., discrete) structure from one or more other structures of the header signal contact **120**.

FIG. **6** is a perspective view of an embodiment of one of the header ground shields **122**. FIG. **7** is another perspective view of the header ground shield **122** viewed in a different orientation as compared to FIG. **6**. Optionally, the header ground shields **122** are substantially similar.

Referring now to FIGS. **5-7**, the header ground shields **122** are sized and shaped to provide electrical shielding around the pair of header signal contacts **120** (not shown in FIGS. **6** and **7**). The header ground shields **122** each include a first mating end **442** and an opposite second mating end **444**. The first mating end **442** is configured to extend into the first cavity **116** (not shown in FIGS. **6** and **7**) for mating with the grounding contacts **236** (shown in FIG. **2**) of the first receptacle connector **104** (shown in FIGS. **1**, **2**, **11**, and **12**), while the second mating end **444** is configured to extend into the second cavity **118** (shown in FIGS. **1**, **4**, **5**, and **12**) for mating with the grounding contacts **336** (shown in FIG. **3**) of the second receptacle connector **106** (shown in FIGS. **1**, **3**, **11**, and **12**), or vice versa.

In the illustrated embodiment, the header ground shields **122** are C-shaped and provide shielding on three sides of the pair of header signal contacts **120**. The header ground shields **122** have a plurality of walls in the illustrated embodiment, namely three planar walls **452**, **454**, **456**. The walls **452**, **454**, **456** may be integrally formed as a single, unitary structure, or alternatively, one or more of the walls **452**, **454**, and/or **456** may be a separately (i.e., discretely) formed structure. The wall **454** defines a base wall or top wall of the header ground shield **122**. The walls **452** and **456** define side walls that extend from the base wall **454**. The side walls **452** and/or **456** are optionally generally perpendicular to the base wall **454**, as is shown in the illustrated embodiment (other angles such as oblique angles may be provided in other embodiments). In the illustrated embodiment, the bottom of each header ground shield **122** is open between the side walls **452** and **456**. Either the header ground shield **122** associated with another pair of header signal contacts **120** or the orphan ground shield **400** (not shown in FIGS. **6** and **8**) provides shielding along the open, fourth side such that each of the pairs of header signal contacts **120** is shielded from each adjacent pair in the same column C (described below; not shown in FIGS. **6** and **7**) and the same row R (described below; not shown in FIGS. **6** and **7**).

The header ground shields **122** may be provided with other configurations, sizes, shapes, and/or the like in other embodiments. The header ground shields **122** may be provided with more or less (i.e., any number of) walls in other embodiments. The walls of the header ground shield **122** may be bent or angled rather than being planar. In some other embodiments, the header ground shields **122** may provide shielding for individual header signal contacts **120** or sets of contacts having more than two header signal contacts **120**.

The header ground shield **122** includes one or more interference bumps **462** formed in the walls **452**, **454**, and/or **456**. The interference bumps **462** engage the header housing **110** (not shown in FIGS. **6** and **7**), such as inside the ground shield opening **406** (not shown in FIGS. **6** and **7**), to hold the header ground shield **122** in the ground shield opening **406** by an interference fit.

In the illustrated embodiment of the header ground shields **122**, the various structures (e.g., the first mating end **442**, the second mating end **444**, the side wall **452**, the base wall **454**, and/or the side wall **456**) of each of the header ground shields **122** are integrally formed as a single, unitary structure. Alternatively, one or more of the various structures of a header ground shield **122** is separately (i.e., discretely) formed as a separate (i.e., discrete) structure from one or more other structures of the header ground shield **122**.

FIG. **8** is a perspective view of the header transition connector **102** illustrating a cross section of the header transition connector **102**. The header ground shields **122** optionally extend an entire length of the header signal contacts **120** from the tip of the first mating end **422** to the tip of the second mating end **424**, as is shown in FIG. **8**. Optionally, because the first receptacle connector **104** (shown in FIGS. **1**, **2**, **11**, and **12**) or the second receptacle connector **106** (shown in FIGS. **1**, **2**, **11**, and **12**) is securely coupled to the header transition connector **102** as a header assembly **500** (shown in and described below with respect to FIG. **12**), the first mating ends **422** of the header signal

contacts **120** and the first mating ends **442** of the header ground shields **122** do not have the same mating and unmating requirements and built-in tolerances as the second mating ends **424** and **444**. As such, the first mating ends **422** of the header signal contacts **120** may be shorter than the second mating ends **424** of the header signal contacts **120**, and the first mating ends **442** of the header ground shields **122** may be shorter than the second mating ends **444** of the header ground shields **122**, which may result in a reduction in the amount of materials used to manufacture (i.e., fabricate) the electrical connector system **100** (shown in FIGS. **1**, **11**, and **12**). The amount of plating (e.g., gold plating) may be reduced. The amount of electrical stub may be reduced.

Referring again to FIG. **4**, in the illustrated embodiment, the first mating ends **422** of the header signal contacts **120** are arranged within the cavity **116** in an array of the rows R and the columns C. In the illustrated embodiment, the header signal contacts **120** within each pair are arranged in the same column C. The second mating ends **424** (FIG. **5**) of the header signal contacts **120** are arranged within the cavity **118** (shown in FIGS. **1**, **4**, **5**, and **12**) in an array of the rows R and the columns C in a substantially similar (e.g., identical, matching, mirrored, and/or the like) manner to the arrangement described above and illustrated in FIG. **4** with respect to the first mating ends **422**.

In the illustrated embodiment, the first mating ends **442** (FIG. **5**) of the header ground shields **122** are arranged within the cavity **116** in an array of the rows R and the columns C. The second mating ends **444** of the header ground shields **122** are arranged within the cavity **118** in an array of the rows R and the columns C in a substantially similar (e.g., identical, matching, mirrored, and/or the like) manner to the arrangement described above and illustrated in FIG. **4** with respect to the first mating ends **442**.

Although ten rows R are shown, the header transition connector **102** may include any number of the rows R to correspond with the number of rows of the first and second receptacle connectors **104** and **106** (FIG. **1**). Although six columns C are shown, the header transition connector **102** may include any number of the columns C to correspond with the number of columns of the first and second receptacle connectors **104** and **106** (FIG. **1**). Each of the rows R may be referred to herein as a "first" and/or an "other" row. Each of the columns C may be referred to herein as a "first" and/or an "other" column.

Referring again to FIGS. **6** and **7**, the header ground shield **122** optionally includes one or more spring arms **480**. Each spring arm **480** is configured to engage in physical contact with an adjacent header ground shield **122** within the same column C (FIG. **4**) to electrically common the two adjacent header ground shields **122** within the column C. In the illustrated embodiment, each spring arm **480** extends outward from the base wall **454**. Each spring arm **480** extends outward to an end **482** having an engagement surface **484**. Each spring arm **480** is configured to engage in physical contact with the adjacent header ground shield **122** within the same column C at the engagement surface **484**.

In the illustrated embodiment, the end **482** of each spring arm **480** is resiliently deflectable along an arc B in the direction D from the natural resting position of the spring arm **480** shown in FIGS. **6** and **7**. The resilience of the spring arm **480** (i.e., the bias of the end **482** of the spring arm **480** to the natural resting position thereof) generates an engagement force between the engagement surface **484** and the adjacent header ground shield **122** within the same column C to provide a reliable engagement and thus electrical connection between the two header ground shields **122**.

Although two spring arms **480** are shown, each header ground shield **122** may include any number of the spring arms **480** for engaging in physical contact with any number of other header ground shields **122**. Moreover, each spring arm **480** may alternatively have any other location(s) along the header ground shield **122** than the locations shown herein.

The header ground shield **122** optionally includes one or more tabs **460**. Each tab **460** is configured to engage in physical contact with the spring arm **480** of an adjacent header ground shield **122** within the same column C to electrically common the two adjacent header ground shields **122** within the column C. In the illustrated embodiment, each tab **460** extends outward from a corresponding side wall **452** or **456** at a respective end **464** or **466** thereof. Each tab **460** extends outward to an engagement surface **468**. Each tab **460** is configured to engage in physical contact with the spring arm **480** of the adjacent header ground shield **122** within the same column C at the engagement surface **468**. The ends **464** and **466** of the side walls **452** and **456** include the engagement surface **468** of the corresponding tab **460**.

Although two tabs **460** are shown, each header ground shield **122** may include any number of the tabs **460** for engaging in physical contact with any number of locations on other header ground shields **122**. Moreover, each tab **460** may additionally or alternatively have any other location(s) along the header ground shield **122** than the locations shown herein.

Optionally, the tabs **460** are used to stop or locate the header ground shield **122** in the ground shield opening **406** (shown in FIGS. **4** and **5**), for example to limit the amount that the header ground shield **122** is loaded into the ground shield opening **406**. The tabs **460** may define push surfaces for pushing or loading the header ground shield **122** into the ground shield opening **406**. Optionally, the first receptacle connector **104** (shown in FIGS. **1**, **2**, **11**, and **12**) or the second receptacle connector **106** (shown in FIGS. **1**, **3**, **11**, and **12**) may be positioned immediately behind the tabs **460** when loaded into the first cavity **116** (shown in FIGS. **1**, **4**, **5**, **11**, and **12**) to block the header ground shield **122** from being pushed out of the ground shield opening **406**, for example when the other receptacle connector **104** or **106** is loaded into the second cavity **118** (shown in FIGS. **1**, **4**, **5**, and **12**).

Optionally, the header ground shield **122** includes one or more spring arms **486** configured to engage in physical contact with an adjacent header ground shield **122** within the same row R (FIG. **4**) to electrically common the two adjacent header ground shields **122** within the row R. In the illustrated embodiment, the spring arm **486** extends outward from the first side wall **452**. The spring arm **486** extends outward to an end **488** having an engagement surface **490**. The spring arm **486** is configured to engage in physical contact with the adjacent header ground shield **122** within the same row R at the engagement surface **490**.

In the illustrated embodiment, the end **488** of each spring arm **486** is resiliently deflectable along an arc E in the direction F from the natural resting position of the spring arm **486** shown in FIGS. **6** and **7**. The resilience of the spring arm **486** (i.e., the bias of the end **488** of the spring arm **486** to the natural resting position thereof) generates an engagement force between the engagement surface **490** and the adjacent header ground shield **122** within the same row R to provide a reliable engagement and thus electrical connection between the two header ground shields **122**.

Each header ground shield **122** may include any number of the spring arms **486** for engaging in physical contact with one or more other header ground shields **122**. In the illustrated embodiment, the header ground shield **122** includes only a single spring arm **486**. The spring arm **486** may alternatively have any other location(s) along the header ground shield **122** than the location shown herein.

In some other embodiments, the header ground shield **122** does not include any of the spring arms **486** such that the header ground shield **122** is not configured to be engaged in physical contact (and thus not electrically commoned with) adjacent header ground shields **122** within the same row R. Moreover, in some other embodiments, the header ground shield **122** does not include any of the spring arms **480** such that the header ground shield **122** is not configured to be engaged in physical contact (and thus not electrically commoned with) adjacent header ground shields **122** within the same column C.

Referring again to FIG. **4**, at least some of the header ground shields **122** are electrically commoned with each other within the header housing **110** of the header transition connector **102**. For example, a group of the header ground shields **122** may be electrically commoned with each other within the header housing **110**. Electrically commoning at least some of the header ground shields **122** within the header housing **110** may provide an electrical connector system **100** that mates the receptacle connectors **104** and **106** together without a midplane circuit board but that behaves electrically as if a midplane circuit board is present. Electrically commoning at least some of the header ground shields **122** within the header housing **110** may enable the header transition connector **102** to cancel and/or reduce signal noise, to improve inter-pair signal skew, to match and/or provide a predetermined impedance, and/or the like. The header ground shields **122** within the group are electrically commoned within the header housing **110** via engagement of the header ground shields **122** so as to provide a continuous electrical pathway from any one header ground shield **122** of the group to all other header ground shields **122** of the group, as will be specifically described below with respect to the illustrated embodiment.

The group of the header ground shields **122** that are electrically commoned may include any number of the overall number of header ground shields **122**. In some embodiments, the group of the header ground shields **122** that are electrically commoned includes all of the header ground shields **122** of the header transition connector **102**. Moreover, any particular header ground shields **122** may be included within the group of header ground shields **122** that are electrically commoned within the header housing **110**. The number of and particular header ground shields **122** within the group of electrically commoned header ground shields **122**, as well as the pattern, configuration, relative arrangement, and/or the like of the group of electrically commoned header ground shields **122**, may be selected to provide the header transition connector **102** with a predetermined electrical performance (e.g., to cancel and/or reduce signal noise, to improve signal skew, to match and/or provide a predetermined impedance, and/or the like)

FIG. **9** is an elevational view of a portion of the header transition connector **102**. Referring now to FIGS. **4**, **8**, and **9**, in the illustrated embodiment, within each column C, the spring arms **480** of the header ground shields **122** are engaged in physical contact with the tabs **460** of adjacent header ground shields **122** within the same column C. Specifically, and referring now solely to FIGS. **8** and **9**, within each column C, the engagement surfaces **484** of the spring arms **480** are engaged in physical contact with the engagement surfaces **468** of the corresponding tabs **460** of adjacent header ground shields **122** within the same column C. The engagement in physical contact of the engagement surfaces **484** and **468** electrically connects adjacent header ground shields **122** within the same column C such that at least some of the header ground shields **122** within the column C are electrically commoned together.

Referring again to FIG. **4**, any number, and any particular ones, of the header ground shields **122** within each column C may be electrically commoned. In the illustrated embodiment, all of the header ground shields **122** within each column C (excepting the orphan ground shields **400**) are electrically commoned. In some other embodiments, the orphan ground shield **400** of one or more columns C is electrically commoned with one or more other header ground shields **122** of the same column C, for example using a similar structure to the spring arms **480** and/or the tabs **460** and/or using another structure.

Any number, and any particular ones, of the columns C may include header ground shields **122** that are electrically commoned. In the illustrated embodiment, all of the columns C include header ground shields **122** that are electrically commoned.

In the illustrated embodiment, within each row R, the spring arms **486** of the header ground shields **122** are engaged in physical contact with the side walls **456** of adjacent header ground shields **122** within the same row R. Specifically, and referring now to FIG. **10**, within each row R, the engagement surfaces **490** of the springs arms **486** are engaged in physical contact with the side walls **456** of adjacent header ground shields **122** within the same row R. The engagement in physical contact of the spring arms **486** and the side walls **456** electrically connects adjacent header ground shields **122** within the same row R such that at least some of the header ground shields **122** within the row R are electrically commoned.

Referring again to FIG. **4**, any number, and any particular ones, of the header ground shields **122** within each row R may be electrically commoned. In the illustrated embodiment, all of the header ground shields **122** within each row R are electrically commoned. Any number, and any particular ones, of the rows R may include header ground shields **122** that are electrically commoned. In the illustrated embodiment, all of the rows R include header ground shields **122** that are electrically commoned. In some other embodiments, two or more of the orphan ground shields **400** within the row R of the orphan ground shields **400** are electrically commoned, for example using a similar structure to the spring arms **486** and/or using another structure.

Although the illustrated embodiment includes both header ground shields **122** electrically commoned within the same column C and header ground shields **122** electrically commoned within the same row R, the header transition connector **102** is not limited thereto. For example, in some other embodiments, the header transition connector **102** only includes electrically-commoned header ground shields **122** within one or more columns C (i.e., does not include any header ground shields **122** that are electrically commoned with one or more other header ground shields **122** within the same row R). Electrically commoning the header ground shields **122** only within the columns C may provide the header transition connector **102** with a substantially similar electrical performance as compared with also electrically commoning header ground shields **122** within the same row(s) R. In other words, electrically commoning the header ground shields **122** within the rows R may not provide a

noticeable, substantial, and/or more than trivial improvement in the electrical performance of the header transition connector **102**.

FIG. **11** illustrates the header transition connector **102** poised for mating with the first receptacle connector **104**. The header transition connector **102** is loaded in a loading direction A. The first receptacle connector **104** is configured to be received in the first cavity **116**. Optionally, securing features may be provided to securely couple the header transition connector **102** to the first receptacle connector **104**. Guide features may be provided to guide mating.

FIG. **12** is a front perspective view of the header transition connector **102** coupled to the first receptacle connector **104** to form the header assembly **500**. The header signal contacts **120** are arranged in an array in the rows R and columns C having a pinout that is complementary to the pinout of the receptacle signal contacts **142** (shown in FIGS. **1** and **2**) and **162** (shown in FIGS. **1** and **3**) of the first and second receptacle connectors **104** (shown in FIGS. **1**, **2**, **11**, and **12**) and **106** (shown in FIGS. **1**, **3**, **11**, and **12**), respectively. For example, the pinouts are defined by the horizontal and vertical spacings between the corresponding signal contacts **120**, **142**, and **162** (for example, the centerline spacings) and the horizontal and vertical spacings from the signal contacts **120**, **142**, and **162** to the header ground shields **122** (for example, the centerline spacings). Optionally, the pinouts of the header transition connector **102** are complementary, matching, identical, and/or the like to the pinouts of the receptacle connectors **104** and **106** to allow mating and interchangeability of the receptacle connectors **104** and **106** into either cavity **116** or **118** of the header transition connector **102**. In other words, the pinouts of the header transition connector **102** may be configured relative to the pinouts defined by the receptacle connectors **104** and **106** such that the receptacle connectors **104** and **106** are interchangeable and configured to be mated to either end **112** or **114** of the header transition connector **102**.

In an exemplary embodiment, the header transition connector **102** is coupled to the first receptacle connector **104** prior to mating with the second receptacle connector **106**. Optionally, the header assembly **500** may form part of an electrical system, such as, but not limited to, a backplane, a network switch, a computer server, and/or the like, where many header assemblies **500** are arranged together, such as, but not limited to, inside a chassis, rack, and/or the like. One or more second receptacle connectors **106** may be coupled to the header assemblies **500** as part of line and/or switch cards. The header transition connector **102**, by being coupled directly to the first receptacle connector **104**, enables mating of the second receptacle connector **106** to the first receptacle connector **104** without the need for a midplane circuit board, and vice versa. The header transition connector **102** changes the mating interface of the first receptacle connector **104** from a receptacle interface to a pin interface for mating with the second receptacle connector **106**, and vice versa.

The embodiments described and/or illustrated herein may provide an improved electrical connector system for mating receptacle connectors without a midplane circuit board.

For example, the embodiments described and/or illustrated herein may provide an electrical connector system that mates receptacle connectors together without a midplane circuit board but that behaves electrically (e.g., from a signal integrity perspective) as if a midplane circuit board is present. Moreover, and for example, the embodiments described and/or illustrated herein may cancel signal noise generated when passing an array of signals between receptacle connectors without a midplane circuit board. The embodiments described and/or illustrated herein may provide an electrical connector system having reduced signal noise as compared to at least some known electrical connector systems that mate receptacle connectors together without a midplane circuit board, for example. Moreover, and for example, the embodiments described and/or illustrated herein may improve inter-pair signal skew when passing an array of signals between receptacle connectors without a midplane circuit board, for example. The embodiments described and/or illustrated herein may provide an electrical connector system having improved signal skew as compared to at least some known electrical connector systems that mate receptacle connectors together without a midplane circuit board, for example.

The embodiments described and/or illustrated herein may provide an electrical connector system having improved signal skew as compared to at least some known electrical connector systems that mate receptacle connectors together with a midplane circuit board.

The embodiments described and/or illustrated herein may provide an electrical connector system having a reduced cost and/or a reduced size as compared to at least some known electrical connector systems for mating receptacle connectors. For example, the embodiments described and/or illustrated herein may provide an electrical connector system that has a reduced cost as compared to at least some known electrical connector systems that mate receptacle connectors together with a midplane circuit board and/or as compared to at least some known electrical connector systems that mate receptacle connectors together without a midplane circuit board. Moreover, and for example, the embodiments described and/or illustrated herein may provide an electrical connector system that mates receptacle connectors together without a midplane circuit board with: (1) a reduced cost as compared to at least some known electrical connector systems that mate receptacle connectors together with a midplane circuit board; and (2) the electrical performance of a midplane circuit board.

It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described embodiments (and/or aspects thereof) may be used in combination with each other. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from its scope. Dimensions, types of materials, orientations of the various components, and the number and positions of the various components described herein are intended to define parameters of certain embodiments, and are by no means limiting and are merely exemplary embodiments. Many other embodiments and modifications within the spirit and scope of the claims will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein." Moreover, in the following claims, the terms "first," "second," and "third," etc. are used merely as labels, and are not intended to impose numerical requirements on their objects. Further, the limitations of the following claims are not written in means-plus-function format and are not intended to be interpreted based on 35 U.S.C. §112(f), unless and until such claim limitations expressly use the phrase "means for" followed by a statement of function void of further structure.

What is claimed is:

1. A header transition connector comprising:

a header housing having a separating wall separating a first cavity from a second cavity;

header signal contacts held by the header housing, the header signal contacts arranged in pairs carrying differential signals, the header signal contacts having first mating ends in the first cavity for mating with a first receptacle connector, the header signal contacts having second mating ends in the second cavity for mating with a second receptacle connector; and

header ground shields held by the header housing, the header ground shields having walls surrounding associated pairs of header signal contacts on at least two sides thereof, the header ground shields having first mating ends in the first cavity for mating with the first receptacle connector, the header ground shields having second mating ends in the second cavity for mating with the second receptacle connector, the header ground shield comprising an engagement feature integral with the corresponding header ground shield, the engagement feature having an engagement surface, wherein at least a group of the header ground shields are electrically commoned via engagement of the engagement feature in physical contact at the engagement surface with at least one other header ground shield of the group within the header housing.

2. The header transition connector of claim **1**, wherein the header ground shields are arranged in an array of rows and columns, the group of header ground shields comprising header ground shields within a first column of the columns.

3. The header transition connector of claim **1**, wherein the header ground shields are arranged in an array of rows and columns, the group of header ground shields comprising header ground shields within a first row of the rows.

4. The header transition connector of claim **1**, wherein the header ground shields are arranged in an array of rows and columns, the group of header ground shields comprising header ground shields within a first column of the columns, at least some of the header ground shields of each other column being electrically commoned with at least some of the other header ground shields of the same column.

5. The header transition connector of claim **1**, wherein the header ground shields are arranged in an array of rows and columns, the group of header ground shields comprising header ground shields within a first column of the columns, at least some of the header ground shields of each other column being electrically commoned with at least some of the other header ground shields of the same column, at least some of the header ground shields of each row being electrically commoned with at least some of the other header ground shields of the same row.

6. The header transition connector of claim **1**, wherein the header ground shields are arranged in an array of rows and columns, the group of header ground shields comprising header ground shields within a first column of the columns, the header ground shields of the group being electrically commoned with each other via engagement in physical contact with another header ground shield of the group that is adjacent within the first column.

7. The header transition connector of claim **1**, wherein the engagement feature is a spring arm that is engaged in physical contact with another header ground shield of the group to electrically common the header ground shields of the group.

8. The header transition connector of claim **1**, wherein the engagement feature is a tab that is engaged in physical contact with another header ground shield of the group to electrically common the header ground shields of the group.

9. The header transition connector of claim **1**, wherein the walls of the header ground shields comprise base walls and side walls that extend from the base walls, the engagement feature extends from the base wall and is engaged in physical contact with an end of a side wall of another header ground shield of the group to electrically common the header ground shields of the group.

10. The header transition connector of claim **1**, wherein the header ground shields are C-shaped.

11. The header transition connector of claim **1**, wherein the walls of the header ground shield comprise a base wall and a side wall that extends from the base wall, the base wall spanning across both header signal contacts of the corresponding pair of header signal contacts.

12. The header transition connector of claim **1**, wherein the header ground shield is a stamped and formed structure, the engagement feature is formed from the header ground shield.

13. A header transition connector comprising:

a header housing having a separating wall separating a first cavity from a second cavity;

header signal contacts held by the header housing, the header signal contacts arranged in pairs carrying differential signals, the header signal contacts having first mating ends in the first cavity for mating with a first receptacle connector, the header signal contacts having second mating ends in the second cavity for mating with a second receptacle connector; and

header ground shields held by the header housing, the header ground shields having walls surrounding associated pairs of header signal contacts on at least two sides thereof, the header ground shields having first mating ends in the first cavity for mating with the first receptacle connector, the header ground shields having second mating ends in the second cavity for mating with the second receptacle connector, the header ground shield comprising an engagement feature integral with the corresponding header ground shield, the engagement feature having an engagement surface, wherein the engagement feature of a first header ground shield is engaged in physical contact at the engagement surface with a second header ground shields such that the first and second header ground shields are electrically connected together.

14. The header transition connector of claim **13**, wherein the header ground shields are arranged in an array of rows and columns, the first and second header ground shields being arranged within the same column.

15. The header transition connector of claim **13**, wherein the header ground shields are arranged in an array of rows and columns, the first and second header ground shields being arranged adjacent to each other within the same column.

16. The header transition connector of claim **13**, wherein the header ground shields are arranged in an array of rows and columns, the first and second header ground shields being arranged within a first column of the columns, at least some of the header ground shields of the first column being electrically commoned with each other within the header housing.

17. The header transition connector of claim **13**, wherein engagement feature is a spring arm that is engaged in physical contact with the second header ground shield to electrically connect the first and second header ground shields.

18. The header transition connector of claim 13, wherein the engagement feature is a tab that is engaged in physical contact with the second header ground shield to electrically connect the first and second header ground shields.

19. The header transition connector of claim 13, wherein the walls of the header ground shields comprise base walls and side walls that extend from the base walls, the engagement feature extends from the base wall and is engaged in physical contact with an end of a side wall of the second header ground shield to electrically connect the first and second header ground shields.

20. The header transition connector of claim 13, wherein the header ground shield is a stamped and formed structure, the engagement feature is formed from the header ground shield.

21. An electrical connector system comprising:

a receptacle connector comprising receptacle signal contacts arranged in pairs carrying differential signals, the receptacle connector comprising a ground shield having ground contacts extending therefrom; and

a header transition connector coupled to the receptacle connector, the header transition connector comprising a header housing holding header signal contacts and header ground shields, the header housing having a separating wall separating a first cavity from a second cavity, the receptacle connector configured to be received in the first cavity, the header signal contacts arranged in pairs carrying differential signals, the header signal contacts having first mating ends that extend in the first cavity and are configured to be mated with the receptacle signal contacts of the receptacle connector, the header signal contacts having second mating ends that extend in the second cavity for mating with a second receptacle connector, the header ground shields having first mating ends in the first cavity for mating with the ground contacts of the receptacle connector, the header ground shields having second mating ends in the second cavity for mating with the second receptacle connector, the header ground shield comprising an engagement feature integral with the corresponding header ground shield, the engagement feature having an engagement surface, wherein the engagement feature of a first header ground shield is engaged in physical contact at the engagement surface with a second header ground shield such that the first and second header ground shields are electrically connected together.

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